

REMARKS

This Amendment is submitted in response to the final Office Action of October 6, 2006 (hereinafter “the Office Action”). Claims 15, 18, and 20-27 remain pending.

All references to the claims, except as noted, will be made with reference to the claim list above beginning on page 2. Line numbers in the Office Action, except as noted, will count every printed line, except the page header, but including section headings. If there is any confusion or questions regarding any aspect of this Amendment, the Examiner is invited to contact the undersigned.

Status

Applicants note with appreciation the withdrawal of the previous rejection under 35 U.S.C. § 102(e). The pending claims now stand rejected under 35 U.S.C. §§ 112 and 103(a).

Amendment

Claims 15 and 23 are amended to correct the indefinite antecedent basis error pointed out in the Office Action. Specifically, “page” in line 15 and 18 of claims 15 and 23, respectively, was changed to “second physical page.” Applicants noted that the Office Action assumed that the correct antecedent is “first physical page” (Office Action, page 4, line 10). However, since data is copied from the first physical page to the second physical page (see, e.g., claim 15, line 14) it should have been clear that access would be enabled to the second physical page. Since it should have been clear that the correct antecedent to “page” in line 15 of claim 15 was “the second physical page,” Applicants respectfully submit that no further consideration and or search is made necessary by this change.

In addition, the dependencies of claims 24-27 were changed from “22” to “23.” The typographical error in claim 26 that was noted in the Office Action (page 3 line 13) is also corrected. Again, the correct dependencies should have been clear from the fact that claims 24-27 are directed to a machine readable medium, while claim 22 is directed to a method. Applicants apologize for this oversight. Again, no additional consideration or search should be necessary as a result of this change.

In addition, the typographical error in claim 24 wherein a space was missing between the words, "access" and "prior" is corrected. Applicants thank the Examiner for pointing out these errors.

No new matter has been entered by way of this Amendment. Applicants respectfully request that these amendments be entered and that the outstanding rejections be reconsidered.

Claim Objections

Claims 24 and 26 are under objection for containing typographical errors. Applicants respectfully submit that the present Amendment obviates these objections and reconsideration thereof is respectfully requested.

Claim Rejections – 35 U.S.C. § 112, second paragraph

Claims 15, 18, and 20-27 stand rejected under 35 U.S.C. § 112, second paragraph, for being indefinite. Specifically, the Office Action states that the term, "the page" in line 18 of claims 15 and 23 lacks a definite antecedent basis. Applicants acknowledge and thank the Examiner for pointing out this error. By virtue of the this Amendment, Applicants have addressed this error by replacing "the page" with "the second physical page." Applicants accordingly respectfully request reconsideration of this rejection.

Claim Rejections -- 35 U.S.C. § 103(a)

Claims 15, 18, and 20-27 stand rejected under 35 U.S.C. § 103(a) for being unpatentable over U.S. Patent 6,931,471 issued to Arndt et al. (hereinafter referred to as "Arndt") in view of U.S. Patent Application Publication 2004/0064673 filed by Rogers et al. (hereinafter referred to as "Rogers." Applicant respectfully traverses because the prior art fails to teach or suggest each and every feature set forth in the claims, and because the prior art lacks a teaching, suggestion, or motivation to combine and/or modify the references as proposed by the Office Action.

For obviousness under 35 U.S.C. § 103(a), each and every limitation must be taught or suggested by the prior art reference, or references when combined or modified (MPEP 2143). It should therefore be noted that Applicant need only point out a single limitation in each claim that is not disclosed, taught, or suggested by any reference identified in the Office Action to overcome the prior art-based rejections. The following discussion therefore should not be construed as an exhaustive listing of every distinguishing feature set forth in the claims.

1. The prior art does not suggest a method or machine readable medium that, as set forth in the preambles to the independent claims, “enables data from a first physical page in a memory that is *directly accessible* to input/output devices to a second physical page in the memory.”

Claim 15 sets forth in the preamble, “memory that is directly accessible to input/output devices.” The Office Action suggests that “[n]either independent claim 15 nor claim 23 claims *directly* accessing the memory by a physical address” (page 2, lines 16-17). However, the preamble of each of claims 15 and 23 states “a first physical page in a memory that is directly accessible to input/output devices” (lines 1-2) and it is this *memory* and this *first physical page* that is later referred to in the body of the respective claim. Applicant respectfully refers to MPEP § 2111.02 wherein the effect of a limitation in a preamble is discussed. Specifically, the MPEP states as follows:

If the body of a claim fully and intrinsically sets forth all of the limitations of the claimed invention, and the preamble merely states, for example, the purpose or intended use of the invention, rather than any distinct definition of any of the claimed invention's limitations, then the preamble is not considered a limitation and is of no significance to claim construction. *Pitney Bowes, Inc. v. Hewlett-Packard Co.*, 182 F.3d 1298, 1305, 51 USPQ2d 1161, 1165 (Fed. Cir. 1999).

(Id. at II) (emphasis added). It should be readily apparent that since the claim body recites “the memory” (e.g., at claim 15, line 4) and the preamble defines “memory” as being “directly accessible to input/output devices,” the preamble breathes life and meaning to the invention and should therefore be interpreted as limiting. Applicants therefore respectfully request that the Examiner reconsider his position with respect to the “directly accessing” limitation present in the preambles to claims 15 and 23.

In the “Response to Arguments/Amendments” portion of the Office Action, the Examiner states that “Rogers further teaches that real pages may be accessed directly (i.e., not using virtual addressing) - ¶40; thus such a limitation, even if present in the amended claims is not patentable over Arndt in view of Rogers” (Office Action, page 3, lines 7-9). Applicant agrees that Rogers mentions direct access of physical memory, but *only by the operating system kernel* --- not by input/output devices as set forth in the preamble of the presently pending independent claims (¶40, lines 6-8). However, Applicant acknowledges that it is common for input/output devices to directly access memory by the physical address. Generally, the input/output devices are forced to use the physical address since the mechanism

of translating virtual to physical addresses is controlled by processor hardware and the operating system. In other words, traditional address translation lives inside the computer processor, and the whole point of “DMA” or “Direct Memory Access” is to bypass the computer processor so that I/O accesses do not impact computing performance.

This is why it has previously not been possible to move data from one location in physical memory to another. See, for example, Arndt, col. 1, lines 35-45. Arndt solves the problem of memory being pinned due to accesses by input/output devices by placing an intermediary, i.e., the bridge circuit 130 in Figure 1 of Arndt, allowing input/output devices to use virtual addresses and translate them to the physical addresses of the memory (see, e.g., Arndt, col. 4, lines 25-30). To allow the input/output devices of Arndt to directly access physical memory would destroy the ability of Arndt to safely relocate data in physical memory. Hence, the two concepts are mutually exclusive: Either the system includes a virtual address to physical address translation layer between the input/output devices as taught by Arndt or the system of Arndt will fail to safely move data from one location in physical memory to another when that data is being accessed by an input/output device.

For these reasons and others, Applicant respectfully asserts (1) that claims 15 and 23 positively recite direct access to physical memory by input/output devices, and (2) that the cited prior art fails to teach or suggest this feature. Since the remaining claims depend from one of claims 15 or 23, Applicant respectfully requests reconsideration of the outstanding rejections under 35 U.S.C. § 103(a).

2. The prior art does not teach or suggest “require[ing] that each input/output device first register an access to the memory by a physical address of the memory prior to the access of the memory” as set forth in claim 15 or include a machine readable medium having “program instructions for each input/output device causing the input/output device to first register an access to the memory by a physical address of the memory prior to the access of the memory” as set forth in claim 23.

Applicants acknowledge that Arndt teaches a page table (164 in Figure 1) (also referred to in Arndt as a “translation control entry (TCE) table”) that binds a physical address of a page in memory, a virtual address of a page in memory, and a device accessing the physical address using the virtual address. However, in Arndt, the page table is maintained by a hypervisor 170, which comprises firmware executed by CPU 162 (see, e.g., col. 3, line 66 to col. 4, line 11). Arndt does not teach or suggest requiring that each *input/output device first register an access to the memory . . . by recording a source of data in the memory being accessed on the physical address of each physical page of the memory being accessed.*”

Instead the table is updated outside the sight of the input/output device or its drivers. Note that it is a goal of Arndt that standard drivers can be utilized. See, e.g., col. 5, lines 66-67. Thus, in Arndt, the device is not forced to register memory accesses or do anything out of the ordinary.

Furthermore, in claim 23, a machine readable medium is claimed, wherein the machine readable medium comprises “program instructions for each input/output device causing the input/output device to first register an access to the memory by a physical address of the memory prior to the access . . . the input/output devices registering the access by recording a source of data in the memory being accessed and the physical address of each physical page of the memory being accessed, the recording being made in a page mapping structure.” Arndt includes a hypervisor for updating the page table, therefore it is not done by the input/output devices and there are no program instructions *for each* input/output device causing the registering to happen.

None of the prior art references overcome this deficiency of Arndt. Applicants therefore respectfully submit that claims 15 and 23 contain features that are not known or suggested by the prior art. These claims should be allowed. Since the remaining claims depend from one of claims 15 and 23, Applicants respectfully submit that these claims are allowable for at least the same reasons as claims 15 and 23.

3. The prior art lacks a teaching, suggestion, or motivation to combine and/or modify Arndt and Rogers as proposed in the Office Action, since Arndt is directed to a virtual to physical address translation page table for I/O devices that is managed by a single process executing on a processor to allow for relocation of data being accessed by a an input/output device, and Rogers is directed to a page table managed by a plurality of programs executing on a processor using virtual addresses.

The Office Action admits that “Arndt does not specifically teach obtaining a lock on a page mapping structure” (page 6, lines 11-12). However, the Office Action states that “[i]t would have been obvious . . . to have combined the physical page copying system of Arndt [sic] with the teaching of mapping table locking of Rogers in order to have prevented a new access to the physical page being moved, as the page being moved could be a defective page. . . Preventing accesses to a defective page would have increased data integrity in the system of Arndt” (page 6, lines 17-22). Applicants respectfully disagree.

In the present case, Arndt teaches the use of a page table to bind virtual and physical addresses of memory pages accessed by input/output devices (col. 4, lines 29-33). The page table is managed by a single process, referred to as a hypervisor (col. 4, lines 2-3 and 8-11).

Since only one process is responsible for updating the page table, there is no need to acquire a lock to prevent other processes from changing the table while data is being moved. In contrast, the present invention includes a page mapping structure wherein each attached input/output device registers accesses to physical memory before doing so. Since this necessarily entails multiple processes accessing a single mapping structure, the lock is provided to prevent accesses to the mapping structure during memory copying operations, thereby preventing errors (see, e.g., Application as filed, paragraphs 31-33). Simply put, there was no motivation in the prior art to obtain a lock on the page table because there is no danger in Arndt that the mapping structure will be improperly accessed during a memory copying operation or other procedure by another process. Thus, because there was no suggestion in Arndt or in the prior art as a whole that Arndt suffers from a lack of data integrity, it is not possible for Rogers to “increase data integrity” as suggested in the Office Action (page 6, lines 21-22).

Applicants note that “[t]he mere fact that references can be combined or modified does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination. In re Mills, 916 F.2d 680, 16 USPQ2d 1430 (Fed. Cir. 1990). Since there was no benefit in combining Arndt and Rogers as proposed, there was no motivation. Since there was no motivation, the combination is not *prima facie* obvious. Applicants respectfully request reconsideration and withdrawal of the outstanding rejections.

Applicants respectfully submit that the present Application is now in condition for allowance. A Notice of Allowance is therefore respectfully requested.

If the Examiner has any questions concerning the present amendment, the Examiner is kindly requested to contact the undersigned at (408) 774-6933. If any other fees are due in connection with filing this amendment, the Commissioner is also authorized to charge Deposit Account No. 50-0805 (Order No. SUNMP399). A duplicate copy of the transmittal is enclosed for this purpose.

Respectfully submitted,
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